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WATER-BLOOM TREATMENT BY UNDERWATER PULSED STREAMER-LIKE DISCHARGES

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Abstract

Cyanobacteria blooms (or water blooms) at a water surface of dams or lakes are caused by eutrophia of the water, and have caused serious environmental problems all over the world. Effects of pulsed streamer-like discharges in water on microcystis cells, which form the water bloom, are studied. Especially, microcystis cells before and after irradiating pulsed streamer-like discharges in water are observed by a transmission electron microscope (TEM). The discharges in water collapse gas vesicles of intracellular structure. Then the microcystis cells sink at the bottom of vessel, and keep an inactive state.

I. INTRODUCTION

Water blooms occur at the water surface of dams or lakes due to eutrophia of the water, and have caused serious environmental problems all over the world. The effects of pulsed streamer-like discharges in water [1] on microcystis cells, which form the water bloom, have been studied [2].

In this paper, microcystis cells before and after irradiating pulsed streamer-like discharges in water are observed by a transmission electron microscope (TEM). Furthermore, it is investigated whether microcystis cells sinking at the bottom of vessel after irradiating the discharges in water are dead or inactive.

II. PHYSICAL AND CHEMICAL REACTIONS OF PLASMAS IN WATER

Figure 1 shows the photograph of pulsed streamer-like discharges in water. The diameter of discharge plasmas is

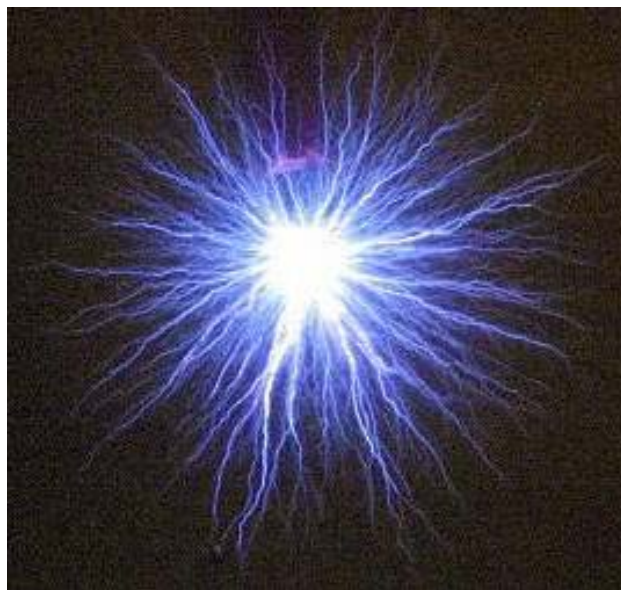


Figure 1. Photograph of pulsed streamer-like discharges in water

about 10 cm. The pulsed power with about several tens' kV output and one μ s pulse width is applied to a rod electrode.

Figure 2 shows the physical and chemical reactions of discharges in water. The water is vaporized and ionized by pulsed power. The discharges in water extend with the speed of several cm/ μ s. The plasma at stem of discharges has the electron temperature of 1 eV and the plasma density of $5 \times 10^{18} \text{ cm}^{-3}$. The discharges in water produce the shock waves, UV light, radicals and extremely high electric field which react with microcystis cells.

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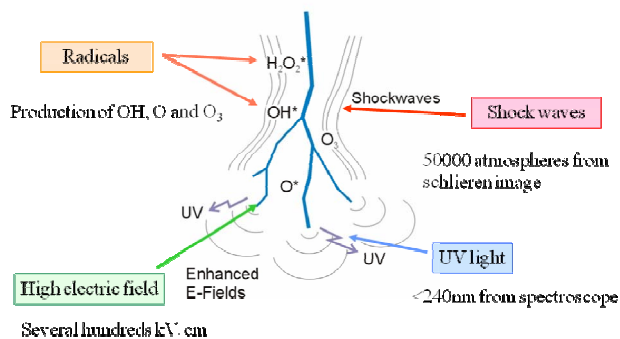


Figure 2. Physical and chemical reactions of discharges in water

III. EXPERIMENTAL APPARATUS OF ALGAE TREATMENT

Figure 3 shows the algae treatment system which is composed of a solar cell, battery, transformer, DC high voltage source and Blumlein type pulse forming network. The repetition frequency is 3 pps (pulses per second). All power to operate the pulsed power generator comes from the solar cell. This system was constructed in 2002.



Figure 3. Algae treatment system in 2002



Figure 4. a large-sized algae treatment system in 2006

Figure 4 shows a large-sized algae treatment system constructed in 2006. This system becomes a product. The MPC (magnetic pulse compressor) is used as a pulsed power generator.

IV. EXPERIMENTAL RESULTS AND DISCUSSIONS

The microcystis cells sink down at the bottom of vessel by irradiating the discharges in water, which are produced by a pulsed power generator. Figure 5 shows the microphotographs. The upper one is the microcystis cells floating in water before irradiating the discharges in water, and the lower one is cells sinking at the bottom of vessel after irradiating the discharges. The black points in the upper photograph, which correspond to gas vesicles, disappear by irradiating the discharges.

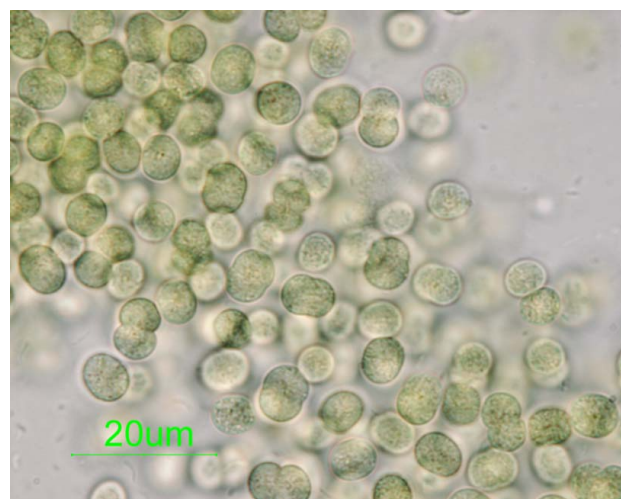
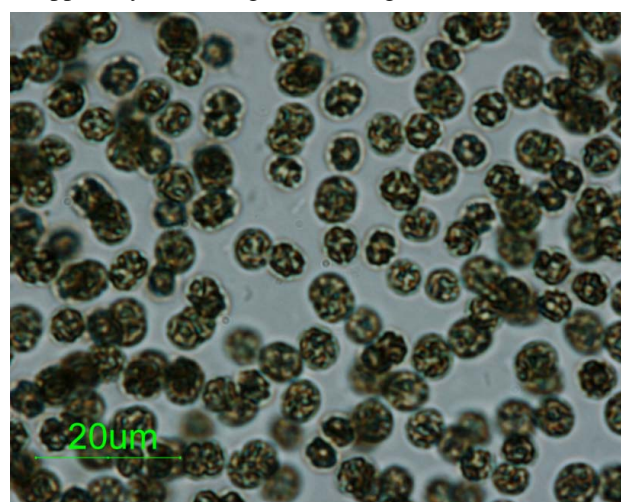


Figure 5. Microphotographs of microcystis cells. The upper and lower one are before and after irradiating the discharges in water, respectively.

In order to investigate the change of the microcystis cells with and without irradiating the pulsed streamer-like discharges in water furthermore, a transmission electron

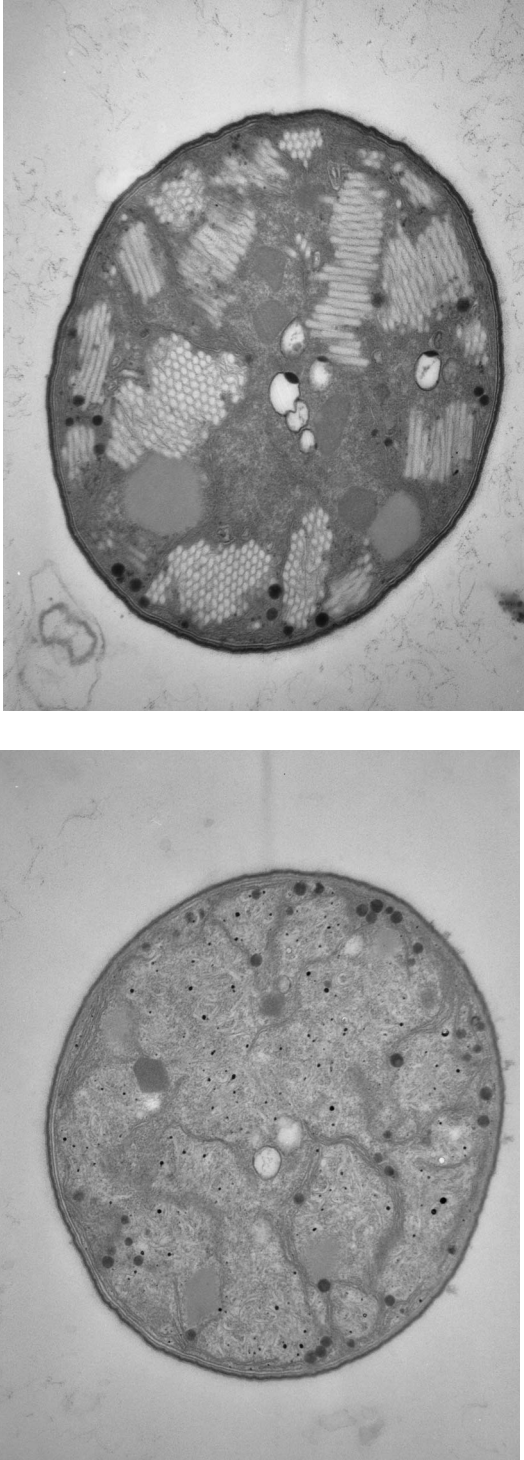


Figure 6. Photographs of microcystis cells taken by TEM. The upper and lower ones are before and after irradiating the discharges in water, respectively.

microscope (TEM) is used. Figure 6 shows the photographs taken by TEM. Gas vesicles with a honey comb shape shown in the upper photograph of Figure 6 disappear clearly by irradiating the discharges in water, as shown in the lower photograph of Figure 6. The other intracellular structures have no damage. Therefore, the microcystis cells sink down by the damage of gas vesicles of intracellular structure.

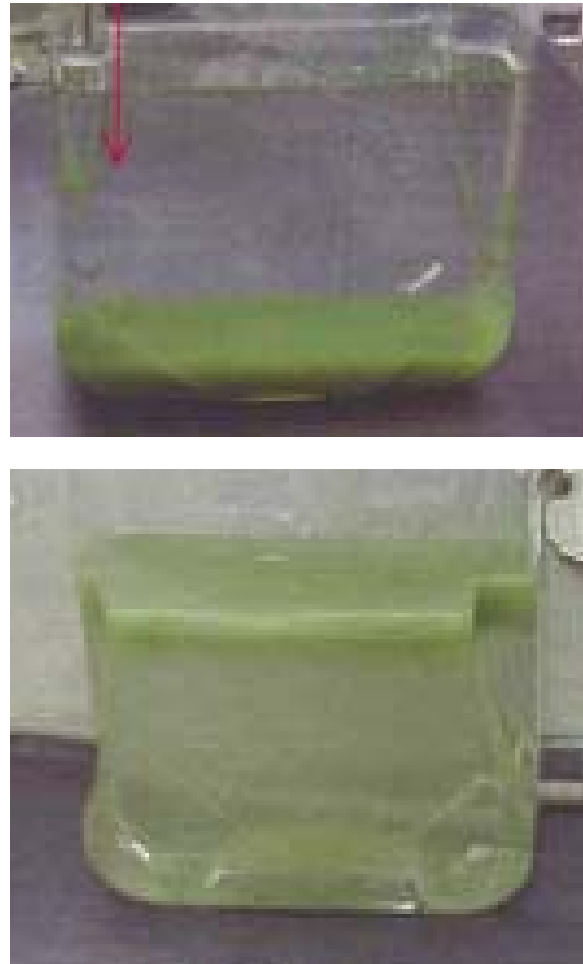


Figure 7. Photographs of vessel with the microcystis. The upper and lower ones are without and with light irradiation for 7days, respectively.

It is important to know whether the microcystis cells sunk down are dead or inactive. The light is irradiated to the microcystis cells sunk down for 7 days. Figure 7 shows the photographs of vessel with the microcystis. The upper one without light shows the cells at 7 days after applying the discharges in water. The cells keep to stay at the bottom. The lower one shows the cell with light for 7 days. The cells become active and float at the surface of water. This means that the gas vesicles are recovered under the light irradiation. We can say that the cells sunk down by the discharges in water are not dead but inactive.

If intracellular structures of cells go into water by destroy of the cell membrane, there is a possibility to cause the second environmental destruction. The enough sun light cannot penetrate till the bottom of dams or lakes. Therefore, the inactive microcystis cells without gas vesicles stay at the bottom over a summer season when the cell division occurs energetically. The discharges produced by pulsed power clean the surfaces of dams and lakes by sinking down the microcystis cells to the bottom. The inactive microcystis cells sunk down might not cause the environmental problem or might be light for environment.

V.SUMMARY

Water blooms occur near the water surface of dams or lakes due to eutrophia of the water, and have caused serious environmental problems all over the world. The effects of pulsed streamer-like discharges in water on microcystis cells, which form the water bloom, are studied. Especially, microcystis cells before and after irradiating the pulsed streamer-like discharges in water are observed by a transmission electron microscope (TEM). The discharges in water collapse gas vesicles of intracellular structure. Then the microcystis cells sink at the bottom of vessel, and keep an inactive state. The inactive microcystis cells sunk down might not cause the environmental problem or might be light for environment.

VI.REFERENCES

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